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ORIGINAL PAPER

Relationship Between ADHD-Like Traits and Emotion Dysregulation in the Adult General Population

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Abstract

Objectives Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder classically characterised by inattention and/or hyperactivity/impulsivity. However, emotion-related problems are also common in people with ADHD, although there is disagreement about their relationship with the classical symptoms of ADHD. Here, we investigated the relationship between emotion dysregulation and ADHD-like traits in a non-clinical group of adults.

Method In a group of 1074 individuals, average age 30.27 years, 656 females, 402 males and 16 who identified as 'other', with 76.8% describing themselves as 'white', were administered the Adult ADHD Self-Report Scale (ASRS) and the Difficulties in Emotion Regulation Scale (DERS) to measure ADHD-like traits and emotion dysregulation, respectively.

Results The Inattention subscale of the ASRS was significantly correlated with all subscales of the DERS. Similarly, the Hyperactivity/impulsivity subscale was correlated with all subscales of the DERS except for the Lack of emotional awareness. The Lack of emotional clarity and Difficulties engaging in goal-directed behaviour subscales of the DERS were significant independent positive predictors of ASRS inattention scores. Non-acceptance of emotional responses, Difficulties engaging in goal-directed behaviour, Impulse control difficulties and Lack of emotional clarity subscales of the DERS were significant independent positive predictors of ASRS hyperactivity/impulsivity scores. In other words, as inattention and hyperactive/impulsive symptoms increased in severity, there was a concomitant increase in the severity of most aspects of emotion dysregulation.

Conclusions The close association between emotion dysregulation and the classical symptoms of ADHD suggests that they may arise from a common dysfunctional substrate and hence treating emotion dysregulation may provide a novel pathway by which to treat the classical symptoms.

Keywords Inattention · Hyperactivity/impulsivity · Adult ADHD Self-Report Scale · Difficulties in Emotion Regulation Scale

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder classically characterised by inattention and/or hyperactive/impulsive symptoms (American Psychiatric Association, 2013; World Health Organization, 2021). It affects around 5% of children (Polanczyk et al., 2015; Zalsman & Shilton, 2016), with approximately two-thirds continuing to experience symptoms as adults (Faraone et al., 2006). The continuation of childhood symptoms, combined with the possibility of adult-onset (Caye et al., 2016; Moffitt et al., 2015), gives an estimated adult prevalence of 2–5% (Simon et al., 2009). ADHD is associated with poorer academic achievement (Arnold et al., 2020; Baweja et al., 2015), difficulties with social functioning (Green & Rabiner, 2012), lower occupational status (Klein et al., 2012), as well as psychological and physical difficulties (Lange et al., 2016; Larson et al., 2011).

ADHD is a multi-faceted condition and in addition to attentional and hyperactive/impulsive symptoms, people with ADHD also exhibit emotion-related problems (Barkley & Fischer, 2010; Beheshti et al., 2020; Ginapp et al., 2023; Graziano & Garcia, 2016; Hirsch et al., 2018; Reimherr et al., 2005; Surman et al., 2013). The estimated prevalence of emotion dysregulation in children with ADHD is 24–50% and slightly higher at 34–70% in adults (Shaw et al., 2014). From a historical perspective, emotion

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dysregulation was considered a diagnostic symptom/sign of 'minimal brain damage', an earlier version of what is now referred to as ADHD (Clements, 1966), but the DSM-III changed it to an associated feature (American Psychiatric Association, 1980). That said, emotional dysregulation is currently seen by some as a central component of the suite of ADHD symptoms (Barkley & Fischer, 2010, Barkley et al., 2010; Faraone et al., 2019; Hirsch et al., 2018; Shaw et al., 2014), even though the symptom is not adequately captured by the current DSM-5 (American Psychiatric Association, 2013) or ICD-11 (World Health Organization, 2021) criteria.

Research has found that emotion dysregulation contributes independently to behavioural issues in ADHD, alongside the classical symptoms (Barkley & Fischer, 2010; Corbisiero et al., 2017; Shaw et al., 2014; Retz et al., 2012b). Reviewing the nature of emotional symptoms in ADHD, Faraone et al. (2019) found that emotional impulsivity and deficient emotion self-regulation cause significant impairments and are prevalent enough and central enough to the disorder to warrant consideration as diagnostic criteria. Importantly, emotion dysregulation does not appear to be a result of a comorbid disorder even when other mental disorders are present in ADHD (Corbisiero et al., 2017; Faraone et al., 2019).

Given the multi-faceted nature of ADHD, a natural question is the extent to which symptoms are distinct from each other. Within ADHD itself, whilst evidence suggests that attentional and hyperactivity/impulsive symptoms can be distinguished (American Psychiatric Association, 2013; World Health Organization, 2021), there is some disagreement about the relationship between these symptoms and emotion dysregulation (Vidal et al., 2014). The relationship between ADHD symptoms is important for two connected reasons: Firstly, the extent to which the symptoms interrelate could give clues to the nature of the underlying pathophysiology. In naïve terms, highly inter-related symptoms might suggest the existence of a common locus of change, with diverse inter-related symptoms allowing the underlying cause to be triangulated (Overton & Coizet, 2020). Secondly, and related to the first, evidence of the inter-relationship between the symptoms of ADHD suggests that it could be possible to treat more than one symptom through interventions with a more restricted focus, giving potential new avenues for treatment development (Cramer et al., 2010; van Stralen, 2016). However, in spite of these advantages of a fuller understanding of the relationship between the symptoms of ADHD, relatively little is known about the relationship between emotion dysregulation and the classical symptoms, although a close association is hinted at by parent ratings (McQuade & Breaux, 2017), and the fact that current pharmacotherapies effectively treat emotional dysregulation as well as the classical symptoms of ADHD (Reimherr et al., 2005; Retz et al., 2012a; Rösler et al., 2010; Ventura et al., 2022).

Although the substrate underlying emotion dysregulation in ADHD is unknown, theories have been proposed. For example, Barkley (2022) considers the presence of emotion dysregulation in ADHD to be explained by the relationship between emotion dysregulation and executive function. According to Barkley (2021), ADHD should be considered an Executive Function Deficit Disorder (EFDD); executive function empowers the mind by shifting attention when necessary, regulating emotions, enabling self-monitoring, and fostering goal-directed behaviour (Logue & Gould, 2014). Accordingly, it has been proposed that people with ADHD may struggle with a variety of difficulties, including emotional self-regulation, because of impaired executive function (Barkley, 2021; Predescu et al., 2020). It is proposed that deficient executive functions underlie the classical symptoms of ADHD as well as emotion dysregulation (Barkley, 2021; Predescu et al., 2020).

Alternative theories have been proposed, in particular an earlier theory that a structure in the midbrain, the superior colliculus, may be dysfunctional in ADHD (Overton, 2008; Overton & Clements, 2009). It has been proposed that the colliculus — a sensory structure — becomes hyper-responsive to sensory stimuli in ADHD and that leads to the pervasive symptom of distractibility (Overton, 2008; Overton & Clements, 2009). Activating the colliculus is known to lead to biophysiological changes akin to those accompanying emotional responses (Keay et al., 1988, 1990), suggesting that collicular dysfunction may play a role in emotion dysregulation in ADHD. This idea is supported by a previous systematic review which showed that ADHD seems to particularly affect emotional reactivity, i.e. the threshold, intensity and duration of affective arousal to inducing stimuli (Graziano & Garcia, 2016). The idea that emotion dysregulation in ADHD is linked to a dysfunction of the distractibility circuitry would predict a strong inter-relationship between emotion dysregulation and the classical symptom of inattention in ADHD, whilst the idea that emotion dysregulation in ADHD is linked to deficient executive function would predict a relationship with impulsivity/hyperactivity as well (Predescu et al., 2020). These possibilities, and their respective implications, were tested in the current study.

For that purpose, the relationship between emotion dysregulation and the classical symptoms of ADHD was assessed using the online presentation of validated scales in a non-clinical adult population with varying degrees of ADHD-like traits. Neurodevelopment can characterised as a series of continuous dimensions pertaining to cognition, behaviour, or neurobiology — with graded levels ranging from typical to atypical functioning (Astle et al., 2022), and likewise ADHD psychopathology can be viewed dimensionally, with symptoms distributed continuously in the general population

(Hudziak et al., 2007; McLennan, 2016; Rodriguez et al., 2007). As a consequence, the participants in the study were drawn from the general population with ADHD-like traits rather than from a clinical population. Given the dimensional nature of ADHD, the relationship between emotion dysregulation and ADHD-like traits in a non-clinical population can provide insights that are of potential therapeutic relevance to a clinical population. Focusing on a non-clinical study group has the added advantage of avoiding the challenge of medication effects interacting with ADHD symptoms.

Method

Participants

English-speaking participants were recruited through the online research platform Prolific Academic (Prolific Academic Ltd., London) and local recruiting from the University of Sheffield. Participants recruited through Prolific were paid £1.00 for their participation in accordance with the recommendations of the website. In all cases, participants had to be over the age of 18. Overall, 1291 participants were recruited; however, data from 128 participants was rejected due to incomplete responses, and a further 3 participants did not meet our inclusion criteria. To control additional sources of variability, participants with a current diagnosis of ADHD ($n = 35$) were also excluded from the study.

The remaining 1074 participants had a mean age of 30.27 (18.36), 656 were female and 402 male, with 16 participants who identified as 'other'. A majority (76.8%) of the cohort described themselves as 'white'. The study was approved by the Research Ethics Committee of the University of Sheffield.

According to standard scoring conventions for the ASRS, a score of 14 or higher on the first 6 items of the scale is considered to be suggestive of ADHD (Kessler et al., 2005). According to this criterion, 222 (20.7% of our sample) had a symptom severity in the clinical range in spite of the exclusion of those with a current diagnosis of ADHD. The mean overall score on the DERS was 93.96 (± 24.90; mean ± 1 SD) and the scores on the subscales were: Non-acceptance of emotional responses, 15.77 (± 6.38); Difficulties engaging in goal-directed behaviour, 15.94 (± 4.82); Impulse control difficulties, 13.83 (± 5.55); Lack of emotional awareness, 15.80 (± 4.69); Inadequate access to emotion regulation strategies, 17.65 (± 7.01) and Lack of emotional clarity, 12.25 (± 4.31).

Procedure

The study was conducted using the online Qualtrics XM platform (International Inc., Utah). After providing participants with information about the study and obtaining informed consent, participants were requested to provide demographic information before completing the ASRS (Kessler et al., 2005) and the DERS (Gratz & Roemer, 2004). After completing the questionnaires, participants were debriefed online about the purpose of the study. Completing the questionnaires took approximately 15 min.

Measures

Alongside a set of demographic questions, participants were administered two scales, the Adult ADHD Self-Report Scale (ASRS-v1.1; Kessler et al., 2005) to measure ADHD-like traits and the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) to measure emotion regulation problems.

Adult ADHD Self-Report Scale (ASRS-v1.1)

The Adult ADHD Self-Report Scale symptom checklist (ASRS-v1.1, hereafter referred to as the ASRS) is an18-question scale developed in conjunction with the World Health Organization and the Workgroup on Adult ADHD. It covers the 18 DSM-IV-TR criteria and measures inattention and hyperactivity/impulsivity symptoms. The ASRS is designed to identify the classical symptoms of ADHD and score the frequency of symptoms (from 0 to 4) ('never', 'rarely', 'sometimes', 'often', 'very often'). The ASRS has two subscales: Inattention (for example: 'when you have a task that requires a lot of thought, how often do you avoid or delay getting started?') and Hyperactivity/impulsivity (for example: 'how often do you feel overly active and compelled to do things, like you were driven by a motor?'), and each subscale contains nine items. The correlation between scores on the ASRS and clinical ratings are highly significant (Adler et al., 2006, 2012). In addition, those correlations remain consistent over time (Adler et al., 2012). Overall, the ASRS has a sensitivity of 56.3%, a specificity of 98.3% and a total classification accuracy of 96.2% versus clinical ratings (Kessler et al., 2005). In our study, the internal consistency of the Adult ADHD Self-Report Scale (ASRS) was assessed using both Cronbach's alpha and McDonald's omega coefficients. The results indicate high levels of reliability for both the total scale and its subscales. The total ASRs scale had a Cronbach's alpha of 0.91 and McDonald's omega of 0.91. Additionally, the Inattention and Hyperactivity/Impulsivity subscales exhibited good reliability, with Inattention having Cronbach's alpha and McDonald's omega of 0.88 and 0.88, and Hyperactivity/Impulsivity having values of 0.84 and 0.83, respectively.

Difficulties in Emotion Regulation Scale (DERS)

The DERS is a brief, 36-item self-report scale designed to assess multiple aspects of emotional dysregulation: Non-acceptance of emotional responses, Difficulties engaging in goal-directed behaviour, Impulse control difficulties, Lack of emotional awareness, Inadequate access to emotion regulation strategies and Lack of emotional clarity. The DERS scale measures awareness, understanding, and acceptance of emotions and the ability to act in desired ways regardless of emotional state. Participants have to indicate how often the statement in each item applies to them, rated on a 5-point scale, 'almost never' (0–10%), 'sometimes' (11–35%), 'about half the time' (36–65%), 'most of the time' (66–90%), 'almost always' (91–100%). The DERS has good test–retest reliability over a period ranging from 4 to 8 weeks, with intraclass coefficients of $\rho I = 0.88$ for total DERS scores and $\rho I = 0.57$ to 0.80 for the six subscales (Gratz & Roemer, 2004). Furthermore, correlations are reasonably high between DERS scores and a commonly used measure of emotion regulation, the Generalized Expectancy for Negative Mood Regulation Scale (overall DERS − 0.69; subscales range from − 0.34 for Lack of emotional awareness to − 0.69 for Inadequate access to emotion regulation strategies; Gratz & Roemer, 2004). In our study, the Difficulties in Emotion Regulation Scale (DERS) demonstrated strong internal consistency. The total DERS scale had a Cronbach's alpha of 0.95 and McDonald's omega of 0.94. Moreover, the six DERS subscales exhibited reliable internal consistency with Cronbach's alpha values ranging from 0.82 to 0.92 and corresponding McDonald's omega values ranging from 0.82 to 0.92.

Data Analyses

Scores were compiled for each subscale of the ASRS and the DERS, and in each case the subscale scores were combined to give overall scores for the scales. The relationship between the scale scores was assessed using correlations and multiple regression, in the latter case taking into consideration appropriate covariates.

Results

The overall mean score on the ASRS was 26.84 (±11.84), with a mean score on the Inattention subscale of 14.67 (±6.63) and the Hyperactivity/impulsivity subscale of 12.17 (±6.18).

Relationship Between Scores on the ASRS and the DERS

Scores on both the ASRS and the DERS showed a significant departure from normality according to the Kolmogorov–Smirnov test (ASRS, $D\,(1074) = 0.04$, $p = 0.002$; DERS, $D\,(1074) = 0.05$, $p < 0.001$) and the Shapiro–Wilk test (ASRS, $W = 0.99$, $p < 0.001$; DERS, $W = 0.99$, $p < 0.001$). Hence, non-parametric correlations were used to investigate the relationship between these variables. Overall scores on the ASRS and the DERS were significantly positively correlated ($r\,(1074) = 0.49$, $p < 0.001$) with a standard alpha of 0.05. Moving on to examine the relationship between the subscales, with 10 variables (6 DERS subscales, 2 ASRS subscales and age/gender), only correlations where $p < 0.005$ were accepted as significant. As shown in Table 1, the Inattention subscale of the ASRS was significantly positively correlated with all the subscales of the DERS ($p < 0.001$). Similarly, the Hyperactivity/impulsivity subscale of the ASRS was positively correlated with all of the subscales of the DERS ($p < 0.001$) except for the Lack of emotional awareness. In other words, as inattention and hyperactive/impulsive symptoms increased in severity, this was associated with concomitant increase in the severity of most aspects of emotion dysregulation. Age was negatively correlated with most of the DERS subscales, except for the Lack of emotional clarity and the Non acceptance of emotional responses subscales, and the Lack of emotional awareness subscale, with which age had a positive relationship. Age was also significantly negatively correlated with both subscales of the ASRS, suggesting that people become less inattentive and hyperactive/impulsive as they become older. However, gender did not significantly correlate with any of the subscales of the ASRS or DERS.

The Predictive Relationship Between the DERS and the ASRS

Multiple regression analysis was used to examine the relationship between the subscales of the ASRS (the outcome variable) and a set of predictor variables. The predictor variables included the subscales of the DERS as well as age. Although gender did not correlate with the subscales of the DERS, and gender does not seem to interact with the presence of the classical symptoms (inattention and impulsivity/ hyperactivity) of ADHD in unmedicated adult patients (Rasmussen & Levander, 2009), probably the closest clinical comparison group to our own, there is uncertainty as to whether that holds for non-clinical subjects, and so gender was also retained as a predictor variable.

Linearity was confirmed by partial regression plots and plots of studentised residuals against the predicted values. The scale scores were independent, as evaluated by a Durbin-Watson statistic. There was no evidence of multicollinearity, as assessed by tolerance values greater than 0.1. The assumption of normality was met, as evaluated by Q-Q plots. The points in the scatterplot of residuals against the predicted values appeared to form a random pattern with an even spread.

Table 1 Zero order correlation between the test variables

Variable	1	2	3	4	5	6	7	8	9	10
1. Inattention	–									
2. Hyperactivity	.69**	–								
3. Non-acceptance	.34**	.34**	–							
4. Goals	.42**	.33**	.48**	–						
5. Impulsive	.37**	.38**	.55**	.59**	–					
6. Awareness	.13**	.07	.16**	−.03	.08**	–				
7. Strategies	.41**	.38**	.70**	.68**	.74**	.07**	–			
8. Clarity	.42**	.34**	.51**	.38**	.51**	.43**	.55**	–		
9. Age	−.12**	−.13**	−.07	−.06**	−.09**	.10**	−.10**	−.03	–	
10. Gender	−.06	−.07	.03	.01	.01	.01	.02	.00	−.00	–

Note. **$p < .001$

Inattention and Hyperactivity refer to the subscales of the ASRS; The subscales of the DERS are as follows: Non-acceptance — Non-acceptance of emotional responses; Goals — Difficulties engaging in goal-directed behaviour; Impulsive — Impulse control difficulties; Awareness — Lack of emotional awareness; Strategies — Inadequate access to emotion regulation strategies; Clarity — Lack of emotional clarity

ASRS Adult ADHD Rating Scale, *DERS* difficulties in Emotion Regulation Scale

Initially, we examined the relationship between the Inattention subscale of the ASRS (the outcome variable) and the 6 subscales of the DERS which correlated with the Inattention subscale of the ASRS as well as age, which also correlated with the Inattention subscale of the ASRS, and gender. The model (Table 2) explained a significant 28.8% of the variance in ASRS inattention scores ($R^2 = 0.29$, F (8,1065) = 55.96, $p < 0.001$). The Lack of emotional clarity and Difficulties engaging in goal-directed behaviour subscales of the DERS were found to be significant positive independent predictors of ASRS inattention scores. Gender was also a significant negative independent predictor of ASRS in attention scores, which — according to our coding — means that when controlling for other variables, females had the highest ASRS inattention scores.

Next, multiple regression analysis was used to examine the relationship between the Hyperactivity/impulsivity subscale of the ASRS (the outcome variable) and the 5 subscales of the DERS which correlated with the Hyperactivity/impulsivity subscale of the ASRS, as well as age and gender. The model (Table 3) explained a significant 23.3% of the variance in ASRS impulsivity/hyperactivity scores ($R^2 = 0.23$, F (8,1065) = 40.54, $p < 0.001$). Non-acceptance of emotional responses, Difficulties engaging in goal-directed behaviour, Impulse control difficulties and Lack of emotional clarity subscales of the DERS were found to be significant independent predictors of ASRS hyperactivity/impulsivity scores. Also, gender and age had a significant negative relationship with ASRS hyperactivity/ impulsivity scores, again indicating that when controlling for other variables, females had the highest ASRS Hyperactivity/ impulsivity scores, and Hyperactivity/impulsivity scores reduced as age increased.

Discussion

The primary objective of this study was to investigate the relationship between ADHD-like traits and difficulties in emotion regulation. As mentioned earlier, people with ADHD not only exhibit the classical symptoms described

Table 2 Multiple linear regression analysis of ASRS Inattention scores predicted by DERS subscale scores and gender/age

	B	*β*	Sig
Constant	3.31		.002
DERS Clarity	0.407	0.265	<.001**
DERS Awareness	0.045	0.032	.297
DERS Impulsive	0.034	0.028	.490
DERS Strategies	0.044	0.046	.358
DERS Non-acceptance	0.032	0.031	.410
DERS Goals	0.371	0.270	<.001**
Gender	−0.814	−0.063	.016*
Age	−0.211	−0.042	.108
R^2	.288		
F	53.96		

The subscales of the DERS are as follows: Clarity — Lack of emotional clarity; Awareness — Lack of emotional awareness; Impulsive — Impulse control difficulties; Strategies — Inadequate access to emotion regulation strategies; Non-acceptance — Non-acceptance of emotional responses; Goals — Difficulties engaging in goal-directed behaviour

ASRS Adult ADHD Rating Scale, *DERS* difficulties in Emotion Regulation Scale

β = standardized regression coefficient. *$p < .05$; **$p < .001$

Notes: This model is the best-fit based on the combination of statistically significant predictor variables, model performance and theoretical relevance to ASRS Inattention scores

Table 3 Multiple linear regression analysis of the ASRS Hyperactivity/impulsivity scores predicting DERS subscale scores and gender/age

	B	*β*	Sig
Constant	5.14		< .001
DERS Clarity	0.226	0.158	< .001**
DERS Awareness	− 0.016	− 0.012	.693
DERS Impulsive	0.212	0.191	< .001**
DERS Strategies	0.005	0.006	.910
DERS Non-acceptance	0.111	0.114	.003*
DERS Goals	0.146	0.114	.003*
Gender	− 0.916	− 0.076	.005*
Age	− 0.347	− 0.074	.006*
R^2	.233		
F	40.54		

The subscales of the DERS are as follows: Clarity — lack of emotional clarity; Awareness — lack of emotional awareness; Impulsive — impulse control difficulties; Strategies — inadequate access to emotion regulation strategies; Non-acceptance — non-acceptance of emotional responses; Goals — difficulties engaging in goal-directed behaviour

ASRS Adult ADHD Rating Scale, *DERS* difficulties in Emotion Regulation Scale

β = standardized regression coefficient. *$p < .05$; **$p < .001$

Notes: This model is the best-fit based on the combination of statistically significant predictor variables, model performance and theoretical relevance to ASRS Inattention scores

in the DSM-5/ICD-11 but also struggle to regulate their emotions (Beheshti et al., 2020; Christiansen et al., 2019; Corbisiero et al., 2013; Fogleman et al., 2018; Pinzone et al., 2019; Reimherr, et al., 2005). The classical symptoms of ADHD are well researched; however, there is disagreement about the relationship between emotion dysregulation and the classical symptoms of ADHD (Vidal et al., 2014). To explore that relationship further, we recruited a non-clinical sample of 1074 participants (61.7% female) with a range of severities of the classical ADHD-like traits of inattention and/or hyperactivity/impulsivity, as measured by the ASRS (Kessler et al., 2005). Scores on these parameters were statistically compared to a simultaneously recorded measure of emotion dysregulation (DERS, Gratz & Roemer, 2004).

Several studies have used the ASRS to assess ADHD symptom severity in non-clinical samples, and the scores in our sample (total ASRS score, 26.84) are in line with previous studies (25.2, Glans et al., 2017; 30.52, Panagiotidi et al., 2018). The prevalence rate however for suspected ADHD in the present study (around one fifth of the sample) is substantially higher than the reported rate of diagnosis in adults (2–5%, Simon et al., 2009), which may reflect a combination of under-diagnosis in the official figures and subjective attractiveness of studies concerning ADHD in those who suspect they have symptoms. Whatever the cause, the presence of participants with higher severity levels ensured we had a wide range of scores for the statistical analyses. Those analyses showed that overall ASRS scale scores were strongly correlated with overall DERS scale scores, suggesting that the symptoms of ADHD do indeed cluster together. Multiple regression found significant predictive relationships between subscales of the DERS and one of both of the subscales of the ASRS.

There was a significant independent positive predictive relationship between ASRS inattention scores and the Lack of emotional clarity, as well as Difficulty engaging in goal-directed behaviour subscales of the DERS. Inability to maintain a goal-directed behaviour may relate to distractibility — a key component of inattention. Distractibility has been considered by many to be one of most common symptoms of the ADHD (Barkley & Ullman, 1975), with clinical accounts often describing those with the disorder as distractible (e.g. Thorley, 1984), as reflected in the DSM-5/ICD-11 criteria (American Psychiatric Association, 2013; World Health Organization, 2021). In terms of emotional clarity, defined as one's ability to identify the emotions one is experiencing, there may be a connection here with mind wandering. Mind wandering is elevated in ADHD (Frick et al., 2020), and in turn, mind wandering is associated with alexithymia (Preece & Gross, 2023), a phenomenon semantically similar to emotional clarity. In effect, attention may drift away to such an extent that there's a reduced capacity to cognitively decode the ongoing stream of biophysiological information that underlies emotional experience.

As with ASRS inattention, there was a significant independent positive predictive relationship between ASRS hyperactivity/impulsivity scores and the Lack of emotional clarity, and Difficulty engaging in goal-directed behaviour subscales of the DERS. Non-acceptance of emotional responses and Impulse control difficulties subscales were also significant independent predictors of ASRS hyperactivity/impulsivity scores. In terms of impulsivity, impaired response inhibition is considered to be a primary deficit in ADHD (Aron & Poldrack, 2005; Barkley, 1997; Dekkers et al., 2016; Doyle, 2006), although more recently, the concept of 'emotional impulsivity' has come to the fore in relation to ADHD, referring to a pattern of variable and intense emotional reactivity (Rosen & Factor, 2015). Impulsivity is at odds with goal-directed behaviour, hence the predictive relationship here, as goal-directed behaviour requires the suppression of competing impulses (Hanif et al., 2012). Impulsivity may also lead to behavioural outcomes, the emotional consequences of which are difficult to accept or difficult to interpret in relation to the behavioural event ('Non-acceptance of emotional responses').

Our findings are consistent with earlier studies showing a relationship between ADHD and emotion dysregulation (Beheshti et al., 2020; Christiansen et al., 2019; Corbisiero

et al., 2013; Fogleman et al., 2018; Pinzone et al., 2019; Reimherr et al., 2005), adding to the evidence base for a connection between the classical symptoms and emotionality. The connection suggests that emotion dysregulation and classical ADHD symptoms may arise from a common underlying mechanism. Our findings extend earlier findings by allowing us to shine some light onto the potential mechanism underlying emotion dysregulation in ADHD. In terms of mechanisms, it has been proposed that people with ADHD may struggle with emotional self-regulation because of impaired executive function (Barkley, 2021; Predescu et al., 2020). Alternatively, emotion dysregulation may be linked to a dysfunction of the distractibility circuitry in the brain, which itself innervates emotion-related systems (Keay et al., 1988, 1990). Impaired executive function has been argued to underlie all the classical symptoms of ADHD (Barkley, 2021; Predescu et al., 2020), whilst the link to distractibility might suggest a more exclusive relationship with inattention. Our results seem to favour impaired executive function, given the high correlation between both subscales of the ASRS and most of the DERS subscales.

A common underlying mechanism is also suggested by the fact that ADHD pharmacotherapies are effective against both the classical symptoms of ADHD and emotion dysregulation in ADHD (Reimherr et al., 2005; Retz et al., 2012b; Rösler et al., 2010; Ventura et al., 2022). However, more work is clearly needed on the relationship between the symptoms as psychostimulants are less effective against emotion dysregulation in ADHD than against the classical symptoms (Lenzi et al., 2018). Nonetheless, the close relationship between the symptoms of ADHD suggests that treatments targeting emotion dysregulation may have a positive impact in the context of inattention and/or impulsivity/hyperactivity. Indeed, preliminary indications are that dialectical behaviour therapy (Linehan, 1993), efficacious in the treatment of emotion dysregulation (Gupta et al., 2019; McMain et al., 2001; Rady et al., 2021), is also efficacious in the treatment of the classical symptoms of ADHD (Hesslinger et al., 2002; Philipsen et al., 2007). One caveat though that needs to be mentioned is that impulsivity/hyperactivity scores had a significant relationship with more DERS subscales than inattention scores, possibly suggesting a stronger shared relationship between emotion dysregulation and some aspects of ADHD than others.

Although ADHD scores have been found to vary according to a number of demographic variables (Adler et al., 2019), in our study, although both inattention and impulsivity/hyperactivity scores were affected by age, age was not a significant independent predictor of ADHD inattention scores. However, it was a significant independent predictor of ADHD impulsivity/hyperactivity scores. Here, the relationship was negative, with impulsivity/hyperactivity scores decreasing as age increased. This is in keeping with the previously reported tendency for inattention to persist into adulthood whilst hyperactivity declines with age (Franke et al., 2018). The tendency in our sample for impulsivity/hyperactivity scores to be higher in females however is not in keeping with much of the literature (e.g. Wilens et al., 2009), although similar findings have been presented elsewhere (Salvi et al., 2019).

Limitations and Future Research

One limitation of the present study is that it is based on self-report rather than observed behaviour. Accordingly, there is the possibility of bias between what participants self-report (McDonald, 2008) and what would be observed behaviourally (e.g. in behavioural tests of emotion dysregulation or tasks that assay dysfunctions in ADHD). Alternative methods may be considered that involve behavioural assessments. Nevertheless, self-report measures are often well correlated with actual behaviour and so should be considered indicative of what may be expected in behavioural studies (e.g. Wash et al., 2017). Regardless of the drawbacks of self-report, high internal consistency was observed for the ASRS, DERS and their subscales. The use of the ASRS subscales, measuring inattention and hyperactivity/impulsivity, and the DERS subscales, is a strength of the study in that it allowed us to dissect the relationship between different ADHD-related symptom patterns and facets of emotion dysregulation, thus adding to the expanding literature on emotionality in ADHD.

Several other limitations that may have affected the results we obtained are worthy of mention. We used a convenience sample for the study, which although large, may not necessarily reflect the population as a whole. That possibility is further reinforced by our use of a commercial research platform to recruit some of our participants, consisting of people who choose to participate in experiments such as ours for payment. Using an online method of delivery for the study would also have narrowed the participant field to those who had access to a computer. Other factors that may affect the relationship between emotion regulation and the classical symptoms of ADHD need to be considered in the future. In particular, ADHD has several common comorbidities, including major depressive disorder (Klassen et al., 2010). Future studies should consider the extent to which comorbidities interact with (explain or mask) the relationship between the classical symptoms of ADHD and emotion dysregulation. Finally, our sample was deliberately constrained to be non-clinical, to explicitly explore the relationship between ADHD-like traits and emotion dysregulation. This led us to exclude the small number of participants who had a self-reported clinical diagnosis of ADHD. Although there is considerable evidence that ADHD should be considered dimensionally, with clinical cases differing from non-clinical cases only in severity (Hudziak et al., 2007; McLennan,

2016; Rodriguez et al., 2007), it would be useful for future work to re-run our study using a sample with a confirmed clinical diagnosis. Furthermore, future work could consider using cognitive measures to assess ADHD-like traits rather than self-report scales.

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Author Contribution SA and PGO were involved in the study concept and design; SA headed up the data analysis, and SA and PGO authored the paper.

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Declarations

Conflict of Interest The authors declare no competing interests.

Ethics Approval This study received ethical approval from the University Ethics Committee at the University of Sheffield.

Consent to Participate Informed consent was obtained from all participants involved in the study. Participants were briefed on the objectives and procedures of the research, and their voluntary participation was secured.

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